Incidence and Thermal Biology of an Invasive Cladoceran, *Daphnia lumholtzi*

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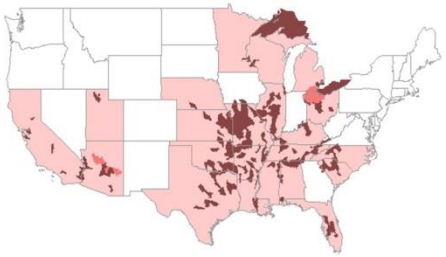
Abstract # 217

Background

Nearly every wetland and aquatic ecosystem in the U.S. is being impacted by non-indigenous species (NIS). Among these, the Atlantic-Gulf region, which is integral to the Gulf Coast fishing industry, has the greatest number of aquatic species introductions. In addition to documenting NIS and assessing their impacts, it is important to summarize the traits that characterize successful invaders. While vertebrate NIS are well monitored, little is known about the invasive potential of invertebrate species. One invertebrate NIS that is generating increasing interest is the subtropical zooplankton *Daphnia lumholtzi*, which has rapidly spread to aquatic systems throughout the US.



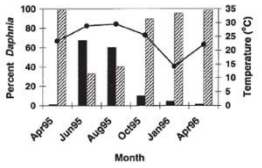
USGS map of *Daphnia lumholtzi* range expansion in the US since its introduction in Texas between 1983-1990

Daphnia lumholtzi is native to Africa, Asia and Australia. It was inadvertently introduced into Texas reservoirs during stocking of Nile perch[1], and has since spread rapidly throughout US waterways.

Thermal tolerance has been linked to its successful colonization of lakes and reservoirs[1,3].

In these systems, D. lumholtzi predominates only during periods of highest water temperatures. In contrast, native species are most abundant at cooler temperatures[1].

Relative densities of *Daphnia* in Lake Okeechobee, FL



East, et al. (1999) and others found that *D. lumholtzi* occupies a vacant thermal niche during warmer periods.

Water column temperature is the primary factor driving population densities

Table 1. Eigenvector correlations (r values) of the first principal component for the limnological variables

Variable	Axis 1
Mean temperature (°C)	0.961
Mean dissolved oxygen (mg l^{-1})	–0.191
Mean pH	0.017
Mean conductivity (ohms)	0.001
Secchi depth (m)	0.013
Total depth (m)	0.012
Phytoplankton biomass	0.197

Principle component analysis of limnological variables affecting Daphnia densities. East, et al., 1999

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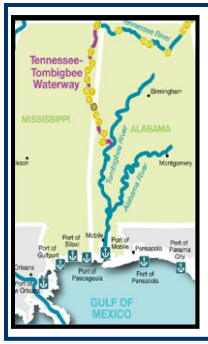
Purpose and Hypothesis

Many studies have documented the success of *D. lumholtzi* in reservoirs and lakes, where high thermal tolerance allows it to exploit a vacant thermal niche during periods of high water temperatures. However, there has been limited characterization of its establishment in estuaries. The Mobile-Tensaw River Delta offers a unique opportunity to investigate *D. lumholtzi's* invasive potential in important estuarine ecosystems. Therefore, we sought to determine 1) if it has established a stable long-term population in this system, 2) how its occurrence overlaps with native *Daphnia* in relation to water temperature, and 3) how its thermal tolerance compares to that of native species.

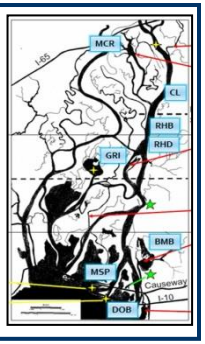


DeVries and colleagues[2] detected very low densities of *Daphnia lumholtzi* in zooplankton samples from the Mobile-Tensaw River Delta in 2002- 2006.

It likely spread to this region through the Alabama and Mississippi reservoir system along the Tennessee-Tombigbee Waterway.

Given the critical functions of estuaries as habitat and nurseries for both freshwater and marine species, it is important to characterize *D. lumholtzi's* invasive potential in the delta.

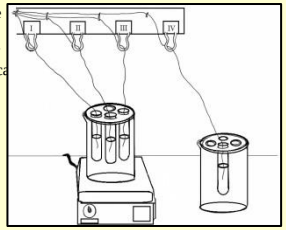
We began sampling the delta in 2011, including sites where it was previously detected.



Materials and Methods

Zooplankton samples were collected monthly over a 2 year period from 8 sites by taking three replicate vertica hauls through the entire water column with a 253µ Wisconsin plankton net.

Daphnia lumholtzi were identified microscopically based on their distinct morphology.



Clonal lineages of wild-caught *Daphnia* were established from a fourth replicate and maintained in continuous culture in the laboratory in culture medium prepared from filter-sterilized lake water diluted with deionized water and adjusted for pH and conductivity.

For thermal studies, daphnia were heated at a constant rate in culture tubes immersed in a heated bath. Tubes were allowed to return room temperature before returning animals to culture for monitoring. Survival was assayed at 4, 24, 36 and 48 hours after thermal exposures to ascertain differences in thermal tolerance between *D. lumholtzi* and native daphnia species.

Bibliography

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Results

1) Has *D. lumholtzi* established a stable population in the Mobile-Tensaw River Delta, and 2) does It overlap with native species in relation to water temperature?

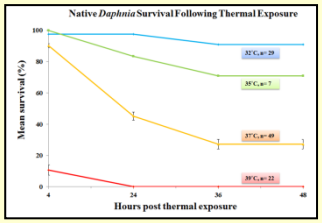
D. ambigua *D. lumholtzi*

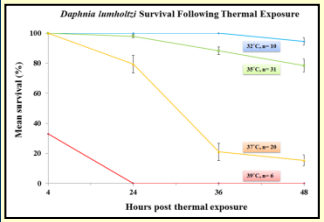
°C	14-19	20-26	27-32
Native *Daphnia*	✚	✚	✚
Daphnia lumholtzi	✚	✚	✚

Presence of *D. lumholtzi* and native species in relation to water temperature. All species occurred at a wide range of temperatures. The image shows a native (left) and a *Daphnia lumholtzi* (right) collected during field sampling.

D. Lumholtzi was present at temperatures ranging from 14˚C to 32˚C; native species were present at temperatures ranging from 17˚C to 32˚C. Both groups occurred at low densities; no pattern of seasonal abundance was observed (data not shown).

3) Is there a difference in thermal tolerance of D. lumholtzi and native daphnia species?





Survival from 36-48 hours following thermal exposures is of particular interest since *Daphnia* typically reach reproductive maturity 4 days after release from the mother, and mature females generally produce a clutch of 6-10 eggs every 3-4 days. Native daphnia survival was greater than seventy percent at 48 hours after exposure to 32 and 35˚C. At 37˚C, survival was less than fifty percent, indicating that this temperature approaches the limits of thermal tolerance for these species.

Similarly, *D. lumholtzi* had high survival rates at temperatures below 35˚C, but showed a sharp decline at 37˚C.

Neither group survived more than 24 hours following exposure to 39 ˚C, indicating that this temperature exceeds their upper thermal limits.

Conclusions

Daphnia lumholtzi has established a stable long term population in the Mobile-Tensaw River Delta. This warrants further studies to fully characterize its invasive potential in this important ecosystem.

Incidence patterns between native daphnia and *D. lumholtzi* do not indicate that it is filling a vacant thermal niche as it does in lakes and reservoirs. Both species have wide thermal tolerance in this ecosystem.

Our thermal tolerance data indicates that there is no difference in survival between *D. lumholtzi* and native daphnia species from 32 to 39 ˚C.

Thus, *D. lumholtzi* does not appear to have a thermal advantage in the estuarine environments. Further studies are needed to characterize other traits that may affect its invasive potential in this ecosystem.